The Beltsville Agricultural Research Center

United States Department of Agriculture

Agricultural Research Service

Program Aid Number 1389

Program Aid 1389
Revised February 1994

Contents

Introduction

This publication briefly describes programs of the U.S. Department of Agriculture's Agricultural Research Service (ARS) in Beltsville, Maryland. The ARS mission is to develop new knowledge and technology needed to solve technical agricultural problems of broad scope and high national priority in order to ensure adequate production of high-quality food, fiber, and other agricultural products to meet the nutritional needs of the American consumer, to sustain a viable food and agricultural economy, and to maintain a quality environment and natural resource base.

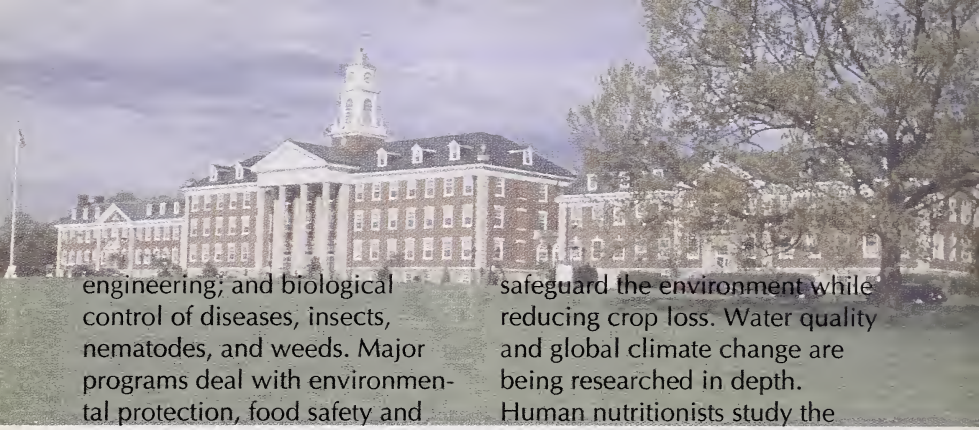
ARS research at Beltsville addresses all six ARS program objectives: (1) Soil, water, and air conservation; (2) plant sciences; (3) animal sciences; (4) commodity conversion and delivery; (5) human nutrition; and (6) integration of systems. Research that contributes to these objectives is conducted in the five institutes (Natural Resources, Plant Sciences, Livestock and Poultry Sciences, Product Quality and Development, and the Beltsville Human Nutrition Research Center) of the Beltsville Agricultural Research Center (BARC) and at the U.S. National Arboretum.

BARC is located on 7,000 acres of land in Beltsville, Maryland. The U.S. National Arboretum is located on 444 acres in Northeast Washington, D.C.; its hills overlook the Capitol and the Washington Monument to the South.

The 47 laboratories and management units of BARC and the Arboretum are listed below. A research index that supplements this brochure indicates who to contact for information on specific research topics.

Research programs at Beltsville encompass great breadth and scope, from conservation of our soil, water, and air resources to human nutrition, and family and systems economics. The research ranges from very basic experiments in plant and animal genetics, physiology, and chemistry to applied research in new instrumentation, development and monitoring of germplasm databases, and modeling of complete production systems.

In recent years, the Beltsville Area research program has expanded beyond traditional plant and animal breeding, nutrition, and chemical control of pests to biotechnology; genetic



engineering; and biological control of diseases, insects, nematodes, and weeds. Major programs deal with environmental protection, food safety and health, and sustainable agriculture. Ever-increasing sophistication of instrumentation (such as electron microscopy, mass spectrometry, nuclear magnetic resonance, and near-infrared reflectance spectroscopy) aids scientists who work in state-of-the-art greenhouses, laboratories, controlled-environment chambers, and transgenic animal facilities, as well as in natural field environments.

Animal researchers study livestock diseases, animal nutritional needs, parasitic diseases, and animal genetics and physiology to improve the productivity of cattle, poultry, swine, and sheep. Plant specialists are seeking greater crop yields and quality by developing plants that use light and nutrients more efficiently, that have built-in disease resistance, or that are able to cope with marginal growing conditions. Others develop new methods to fight plant pests, including use of nature's own resources—biological controls and naturally occurring chemicals—that are integrated with better cultural methods to safeguard the environment while reducing crop loss. Water quality and global climate change are being researched in depth. Human nutritionists study the nutrient requirements for optimal health and identify the foods that meet these requirements. Still others work to ensure that meat, milk, and produce reach the consumer with all their natural taste and nutritional value. Beltsville scientists conduct major programs aimed at improving the quality and safety of foods, including prevention of foodborne parasites and chemical contaminants.

Beltsville's record of accomplishments and ongoing programs has made it a world leader in agricultural research. Its international reputation attracts thousands of visitors each year from the United States and abroad. It is the home of several globally-renowned research collections: the National Fungus Collection, the National Parasite Collection, and outstanding collections of insects, nematodes, seeds, nitrogen-fixing bacteria, and plants. The Beltsville Agricultural Research Center is among the largest and most diversified agricultural research complexes in the world.

Laboratories and Other Management Units in Beltsville and Nearby Locations

Natural Resources Institute
- Climate Stress
- Hydrology
- Remote Sensing Research
- Environmental Chemistry
- Soil Microbial Systems
- Systems Research
- Electron Microscope

Plant Sciences Institute
- Fruit
- Vegetable
- Soybean and Alfalfa Research
- Weed Science
- National Germplasm Resources
- Plant Molecular Biology
- Systematic Botany and Mycology
- Molecular Plant Pathology
- Biocontrol of Plant Diseases
- Nematology
- Systematic Entomology
- Insect Neurobiology and Hormone
- Insect Chemical Ecology
- Insect Biocontrol
- Bee Research

Livestock and Poultry Sciences Institute
- Biosystematic Parasitology
- Protozoan Diseases
- Helminthic Diseases
- Zoonotic Diseases
- Milk Secretion and Mastitis
- Livestock Insects
- Nonruminant Animal Nutrition
- Ruminant Nutrition
- Gene Evaluation and Mapping
- Germplasm and Gamete Physiology
- Animal Improvement Programs

Product Quality and Development Institute
- Pesticide Research
- Horticultural Crops Quality
- Meat Science Research
- Family Economics Research
- Instrumentation and Sensing

Beltsville Human Nutrition Research Center
- Food Composition
- Diet and Human Performance
- Metabolism and Nutrient Interactions
- Nutrient Requirements and Functions

U.S. National Arboretum
- Germplasm
- Floral and Nursery Plants Research
- Education
- Gardens

Agricultural Research at Beltsville, Past and Present

In 1910, the U.S. Department of Agriculture first came to Beltsville, Maryland, in suburban Washington, D.C. There it founded a 475-acre experimental farm for animal research. Through the years, the dimensions of the Beltsville Agricultural Research Center have changed—the facility now spans about 7,000 acres and is part of one of the largest undeveloped tracts of land between New York and Washington. BARC is now part of the ARS, USDA's principal in-house research agency.

Over time, research conducted at BARC has continually responded to the changing needs of American agriculture and of the American consumer. A complete listing of science's contributions to our supply of affordable, high-quality food and fiber would fill a book by itself.

At Beltsville, ARS scientists:

- *Contributed to the Green Revolution, a turning point in agriculture that drastically reduced world hunger, by identifying and supplying disease-resistant wheat to plant-breeding centers around the world.*

- ***Pioneered research on plant responses to variations in light quality and day length, which culminated in the chemical isolation of phytochrome, the photoreceptor that regulates many plant growth and development responses to light.***

❧ ***Developed the Beltsville Small White turkey and improved the efficiency of artificial insemination of commercial turkeys.***

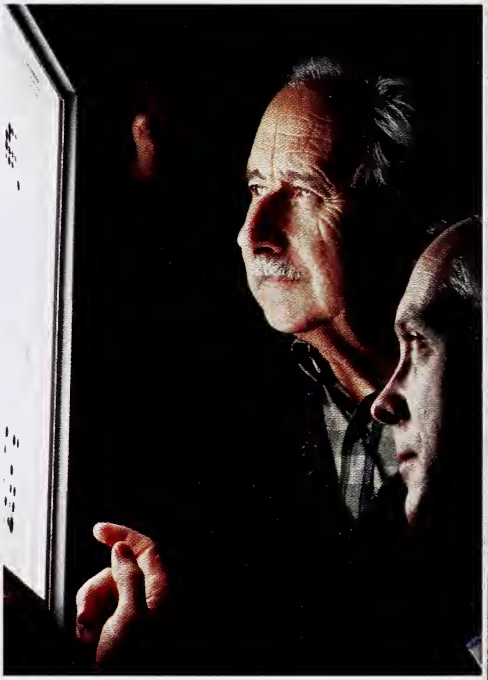
❧ *Developed detergent chemical methods for determining the nutritional value of feedstuff—now widely used throughout the world in both human and animal nutrition.*

❧ *Conducted fundamental research that defined the energy requirements of the lactating dairy cow. These concepts led to a practical feeding system adopted by the National Academy of Sciences.*

❧ *Discovered and synthesized the sex pheromones for several pest insects. Sex pheromones are emitted by insects to attract their mates. These synthetic substances are now used for mass trapping and to survey insect populations for integrating pest management programs.*

❧ *Invented and developed the bug bomb, sparing thousands of lives from malaria and other tropical diseases during World War II and its aftermath.*

❧ *Developed tissue culture techniques enabling cultivation of disease-resistant peach trees.*



❧ ***Discovered plant viroids—a class of disease-causing particles 80 times smaller than viruses. Developed a practical test for the presence of viroids in potatoes.***

❧ ***Developed the near-infrared reflectance spectroscopic technique for rapid evaluation of major quality constituents in food, feed, and agricultural products.***

❧ *Discovered that a group of protozoan parasites (*Sarcocystis *species), long thought to be harmless cysts in the muscles of cattle, sheep, and swine, can actually cause weight loss, induce abortion, decrease milk yields, and even result in animal death.*

❧ *Developed a standardized reference diet for use as a research tool in human metabolic studies.*

❧ *Developed and continue to increase the world's largest germplasm collection of* Rhizobium, *important soil bacteria that raise grain yields of soybeans and forage yields of alfalfa by forming nitrogen-fixing symbioses with the roots of the plant.*

❧ *Discovered the selectivity of the herbicide 2,4-D to kill broadleaf plants (dicots) while doing little damage to grasses (monocots). This discovery, which revolutionized weed control, fostered the agricultural chemical industry.*

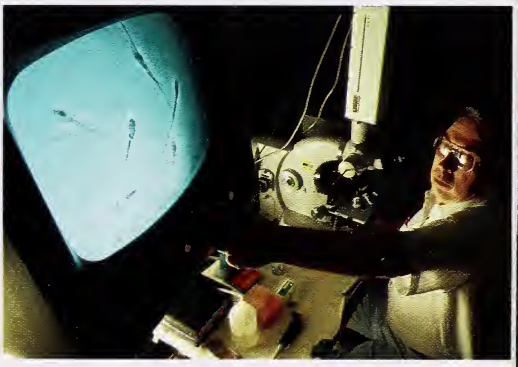
❧ ***Discovered that rice plants grown only from pollen can be chemically selected in the laboratory for increased protein and other desirable characteristics. One rice variety produced this way has 42 percent more lysine (an essential amino acid) than typical rice.***

❧ *Developed a mechanism for coupling the flame ionization detector with a sensitive electrometer to measure the plant hormone ethylene. This enabled plant scientists to measure low amounts of ethylene and led to means of controlling the amount of fruit-ripening ethylene in storage rooms.*

❧ *Discovered a class of plant growth-regulating substances known as brassinolides. These compounds are steroidal in nature and function with other hormones to accelerate plant development and maturation.*

❧ *Developed and introduced many pest-resistant potato varieties, from the famous Katahdin potato of the 1930's to the new superior baking potato bred to grow in the Northeast—BelRus.*

Today's research initiatives address problems of ever-increasing complexity and urgency, so that Beltsville continues to be regarded as the flagship of American agricultural research. In keeping with the Center's tradition of service, the BARC carries out fundamental research and makes pragmatic contributions to the affordability, quality, and availability of food and fiber that reach the marketplace. In recent years, scientists have:



❧ ***Discovered a laser beam technique to identify and separate X- and Y-chromosome-bearing sperm of farm animals. They have further used this technique to pre-select the sex of animals at conception for more efficient meat or milk production.***

❧ ***Detected nutrient deficiencies in corn and soybeans from an aircraft or satellite using a nitrogen-gas laser. Plant leaves fluoresce in specific wavelengths that indicate their status of specific elements, such as iron, nitrogen, and potassium.***

❧ *Discovered that clinical mastitis can be reduced 75 percent by inserting abraded plastic loops in cows' udders. Reduced infections resulted in increased milk yield averaging almost 4 pounds per cow per day.*

❧ *Demonstrated that decreasing animal fat in the human diet and increasing the proportion of fat from vegetable sources significantly reduces high blood pressure.*

❧ *Pioneered research on lowering body fat in swine through genetic selection.*

❧ *Discovered a new synthetic control for fire ants that increases the ratio of drone ants to workers, slowly causing the ant colony to weaken and die. These pests infest 230 million acres in the South.*

❧ ***Created the Germplasm Resources Information Network (GRIN), a computerized database that contains all available information on plant germplasm necessary to improve the quality and productivity of crops.***

❧ *Developed a multiple-volume treatise of detailed taxonomic information on over 15,000 species of North American moths.*

❧ *Developed computerized databases and information files on beneficial organisms, primarily those of foreign origin, as an aid in biological control of pests.*

❧ *Identified the role of macropore flow in soils as a major pathway for movement of pesticides into groundwater.*

❧ *In a cooperative effort with industry, genetically engineered a parasite constituent that stimulates host immunity, an important first step for a vaccine against coccidiosis. This disease of poultry costs U.S. producers almost $300 million a year.*

❧ *Introduced exotic new impatiens germplasm and used ovule-culture to develop otherwise-impossible hybrids to create new kinds of impatiens, a flower-garden bedding plant that is now more popular than the petunia.*

❧ *Originated high-quality, large-fruited blueberry varieties that sparked a new and profitable cultivated blueberry industry.*

❧ ***Discovered a chemical attractant that will cause the spined soldier bug—a type of stink bug that eats other insects—to gather in areas where they may help the farmer and gardener control pest insects.***

❧ *Released to plant breeders four snap bean germplasm lines resistant to all 28 races of* Uromyces phaseoli *(fungus that causes bean rust) that occur in the United States. Snap and dry beans are an important source of protein and energy in the human diet.*

❧ *Developed the first naturally occurring beneficial fungus approved by EPA for biocontrol of plant diseases. This fungus controls "damping off," a major killer of seedlings of ornamentals and vegetables.*

❧ *Developed a diagnostic kit that can detect all members of one of the world's most damaging groups of plant viruses. The broad-spectrum specificity of the test makes it a valuable tool for seed-testers, nurseries, farmers, and research scientists.*

❧ *Developed a snowmelt-runoff model that can predict the amount and timing of water delivery to the 17 irrigated Western States.*

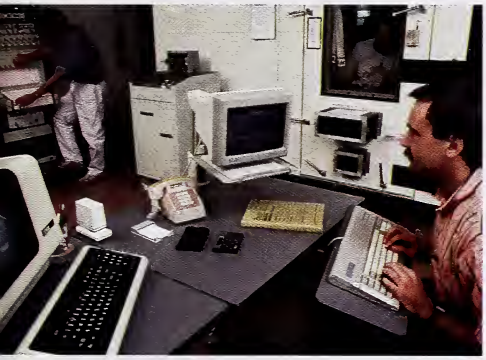
❧ ***Introduced cultivars of crabapples resistant to powdery mildew, fire blight, apple scab, and cedar-apple rust and that possess superior landscape characteristics of superb flowering, fruiting, fall foliage color, and adaptation to a wide range of North American sites.***

❧ ***Developed Abby, a potent strain of virus that kills gypsy moths. It may one day naturally protect trees from the voracious insect without harming people, other animals, or the environment. Scientists tested a number of viral strains before selecting the potent Abby strain. They then found a compound that increases by at least tenfold the number of caterpillars Abby kills. Finally, they developed a cell line in which Abby will grow. A private firm is currently developing the technology into a commercial product.***

❧ *Transferred economically important foreign genes into the genome of swine and sheep to improve growth characteristics, increase disease resistance, and produce biological products in the mammary gland.*

❧ *Developed new and improved analytical procedures for detecting antibiotic residues in meat and milk. These methods are now used by industry, the Food and Drug Administration, and the USDA's Food Safety and Inspection Service.*

❧ *Developed child-rearing cost estimates that are now used in many States for determining child support awards and foster care rates.*



❧ ***Developed a room-sized calorimeter for human studies that permits measurement of 24-hour energy expenditure to help define the interrelationships among diet composition, body composition, and energy expenditure.***

❧ *Developed new techniques for measuring carotenoids (yellow and orange pigments) in fruits and vegetables. These techniques will allow scientists to evaluate the importance of food carotenoids in the reduction of cancer risk.*

❧ *Demonstrated that daily consumption of carrots could increase blood beta-carotene levels nearly 600 percent in humans.*

❧ *Developed genetic concepts that became the foundation for modern plant and animal breeding and proved the value of statistical methods in evaluating inherited characteristics in populations.*

❧ *Enhanced quality of low-fat hamburgers by developing criteria for eliminating defects and improving palatability. These criteria have become the basis for purchase specifications for the National School Lunch Program and rations for the U.S. Armed Forces.*

❧ *Developed role of satellite remote sensing to monitor soil erosion.*

Natural Resources Institute

The Natural Resources Institute serves as a focal point for research on soil, water, and air at BARC. Some of the research performed here is of global significance, including work on water quality, climate change, food safety, sustainable agriculture, erosion control, destruction of toxic substances in waste water, biotechnology, and a host of related environmental concerns.

Developed a disposal unit that uses ozone and micro-organisms to destroy pesticide residues in wastewater.

Climate Stress Laboratory

Much has been written about the potential impact of global climate change. In the Climate Stress Laboratory, scientists are charting out the effects that such change may spell for agricultural crops. They're identifying ways that certain crop cultivars (cultivated varieties) may adapt to changing environmental stress, including the effects of ultraviolet radiation, enriched carbon dioxide, high temperatures, drought, atmospheric pollutants, and mineral stress. For example, one major area of research is the study of carbon partitioning, the means by which a plant allocates important chemical resources.

Researchers examine electron micrographs of cotton root cells to determine areas for image analysis.

Hydrology Laboratory

With an eye to improving tomorrow's water conservation techniques, scientists in the Hydrology Laboratory test new technologies contributing to water resources modeling, prediction, and management. They also develop improved methods for predicting water yield from and for agricultural lands, and for monitoring and evaluating management practices and large-scale environmental changes on water resources.

Remote Sensing Research Laboratory

Collecting data from afar is a technology that offers special promise to agriculture, a field in which there's literally a lot of ground to cover. Remote sensing gives users—they could be farmers, engineers, or national policymakers—access to data that have been transmitted via satellite and other aerospace means. Such real-time information can facilitate up-to-the-moment management and marketing decisions. In the Remote Sensing Research Laboratory, radiospectrum response and ground measurements are used to conceptualize and broaden agricultural applications for this state-of-the-art technology.

Environmental Chemistry Laboratory

Soil sample being taken by lab technician for analysis to determine amount of nitrogen in the soil.

Safeguarding the purity of groundwater is a national priority that cuts across the boundaries of many governmental agencies. In the Environmental Chemistry Laboratory, scientists develop pesticide analytical methods that will be used in support of Federal water quality programs and food safety programs. Here, the ways that pesticides are used are closely examined to reduce the

Scientists examine an *Achromobacter* species isolated by Beltsville chemists in their studies of bacteria that degrade pesticides.

potential transport through soil to groundwater or loss to the atmosphere.

After they're applied, agricultural chemicals don't simply sit there. Scientists learn more each day about what does happen to these chemicals—their movement, absorption, binding, photodecomposition, microbial metabolism, uptake, and volatility. In addition to finding faster, better means of detection, laboratory scientists seek simple technologies for waste disposal. Metabolites and degradation products of agricultural chemicals are identified, as well as the routes by which they enter groundwater, plants, and agricultural food chains.

Fertilizers and heavy metals are also scrutinized to learn how they move through soil, are transformed, and are taken up by plants. The sophistocated technique of magnetic resonance imaging, best-known as a method of diagnosis in medicine, is put to work in this laboratory setting to detect how environmental contaminants affect plants.

Systems Research Laboratory

These scientists perform research that paves the way for other research. They make it possible to take existing knowledge and integrate it into practical technologies that can be transferred to users such as action agencies, farmers, and state organizations. The laboratory links ARS scientists together into interdisciplinary teams to develop and use models, expert systems, and databases to solve important problems. Climate change and water quality are among the high-priority issues in this laboratory.

Electron Microscope Laboratory

Through the use of electron microscopy, scientists develop and adapt new analytical techniques that can be brought to bear on difficult and persistent agricultural problems. For example, microscopy elucidates changes in biological elements, helping solve or explain abnormal structure/function relationships in plant and animal cells. It allows scientists to determine how growth and development in plants and animals are adversely affected by environmental and biological stress factors. And the electron microscope is irreplaceable as an aid in the precise identification of pathogens, parasites, insects, and other agricultural pests.

Kale grown with various rates of inorganic fertilizers is prepared for tests to determine vitamin C content.

Soil Microbial Systems Laboratory

In the past two decades, producers' concerns for the environment have heightened. How can American farmers maintain high levels of productivity and quality, yet use agricultural chemicals as sparingly as possible? Here, scientists look to living organisms as they conduct research on soil microbiology, plant nutrition, and soil microbe/plant root interactions, placing emphasis on organic matter, crop residues, and animal manures. Some of the practical objectives: environmentally friendly ways to control erosion and nutrient runoff and suppress soilborne pathogens, disease-causing organisms, nematodes, insects, and weeds.

Plant Sciences Institute

The mission of the Plant Sciences Institute is to develop biological, chemical, and physical processes and principles, including bioregulation that will:

- Improve pest management systems.
- Improve crop production efficiency.
- Improve conservation of natural resources.
- Improve environmental quality.
- Support regulatory and action agencies.
- Contribute to advances in biotechnology.

Developed first biopesticide-attractant combination for control of the soybean cyst nematode, a major crop pest.

Strawberry varieties have been improved to bear fruit in spring, summer, and fall.

Fruit Laboratory

New varieties of strawberries, blackberries, and blueberries hybridized here at Beltsville continue to bring the American consumer the best in berries, combining disease resistance with superior characteristics. Scientists here are finding ways to micropropagate tree fruits with tissue-culture techniques. The laboratory also looks for ways to prevent fruit diseases, searches for biological controls, and evaluates the role of nutrients in improving fruit quality and of chemicals in regulating growth.

Vegetable Laboratory

Thanks to Vegetable Laboratory scientists who carry out breeding programs and related research, vegetables continue to be better—and better for you. The researchers study such elemental matters as protoplasts (plants' cellular energy factories) and the nature and mechanisms of pest resistance. They're also concerned with ways vegetable crops can be adapted to expand resistance to disease and increase yields. They also work to make vegetables better in terms of their nutritional, marketing, and processing qualities. Pest-control practices developed from the study of insect behavior and ecology help to reduce dependence on chemical pesticides and enable Vegetable Laboratory scientists to plan effective integrated pest control strategies.

Weed Science Laboratory

Scientists work to improve the safety and efficiency of weed-control technology. They study factors that control herbicide activity in plants, as well as the modes and mechanisms of herbicide action. They also

Grow-your-own plant mulches such as hairy vetch can protect row crops from insect infestation, eliminate the need for tillage, and reduce soil temperature.

investigate the bioactivity of natural products. Because herbicides alone may never solve the world's weed problems, Weed Science Laboratory researchers are also preparing integrated weed management strategies for today's agronomic crops.

Molecular Plant Pathology Laboratory

Research on plant viruses, and on diseases formerly thought to be caused by viruses, has led to the discovery of spiroplasmas, viroids, and small viral satellites that reproduce only in plants infected by other viruses. Scientists apply the most novel methods of biotechnology to study these and other plant pathogens and the diseases they cause. They seek to develop new concepts of disease control, including gene pyramiding, induced resistance, biocontrol, and bioregulation of plant/pathogen response mechanisms.

A thorough understanding of nitrogen metabolism lays the groundwork for a bumper crop of soybeans.

Soybean and Alfalfa Research Laboratory

The mission of this laboratory is to reduce the costs of producing soybeans and alfalfa. Special emphasis is on soybean and alfalfa improvement, such as higher yields, disease and insect resistance, and more efficient nitrogen fixation. Laboratory personnel maintain the USDA Rhizobium Culture Collection.

National Germplasm Resources Laboratory

Plant genetic resources are vital for improving the quality and production of crops important to world agriculture, and scientists supporting the U.S. National Plant Germplasm System take good care of these resources. In the laboratory, researchers collect, document, preserve, evaluate, enhance, and distribute the world's germplasm (seeds, rootstocks, tissue specimens, etc.—in short, anything a plant can be grown from). Scientists procure plant germplasm through international and domestic exchanges of plants and seeds, document and assign unique identifiers to incoming material, and respond to foreign requests for germplasm. They develop methods to prioritize needs, arrange for and participate in international and domestic plant explorations, and study the natural history of crop plants and their progenitors. The laboratory maintains numerous databases and issues information summaries on useful and potentially useful plants of the world. Scientists concerned with plant quarantine see to it that certain imported germplasm is isolated and tested for pathogens before it is released.

Germplasm collected on the slopes of a volcano in Ecuador will become a valued accession in the National Plant Germplasm System.

Sterile techniques enable scientists to test quarantined plants for disease.

Plant Molecular Biology Laboratory

Scientists in the Plant Molecular Biology Laboratory unravel basic molecular mechanisms involved in plant growth, development, and senescence, as they look into the smallest units of life. Using state-of-the-art technology, they advance the course of modern plant genetics, molecular biology, and tissue culture techniques. While the objects of study may be microscopic in size, research objectives are substantial. Plant Molecular Biology Laboratory scientists aim to genetically improve crops in terms of quality, efficiency, productivity, and disease resistance.

A collection of rare reference books helps Beltsville mycologists distinguish deadly mushroom species from harmless ones.

Chloroplasts are added to an oxygen electrode in a photosynthesis study.

Systematic Botany and Mycology Laboratory

Scientists study the systematics of plants and fungi of economic value to agriculture to permit accurate identifications and to provide an understanding of their relationships and their distribution in the ecosystem. The staff maintains the U.S. National Seed Herbarium and the National Fungus Collection. Information is made available on practically everything known about fungi—including mushrooms, yeasts, and molds—that are beneficial or harmful to plants, animals, and humans.

Systematic Entomology Laboratory

Thousands of species of insects are known; some of them are impossible to conclusively identify with the naked eye. Yet the fate of an entire crop may depend on a distinction between friend and foe. Scientists at the Systematic Entomology Laboratory develop systems of classification of insects and mites distributed throughout the world. This basic research supports biological control, pest suppression, forestry, and other broad areas of agricultural and biological research and action programs. Responsibilities also include an international identification service that supports the needs of Federal, State, university, and private user organizations.

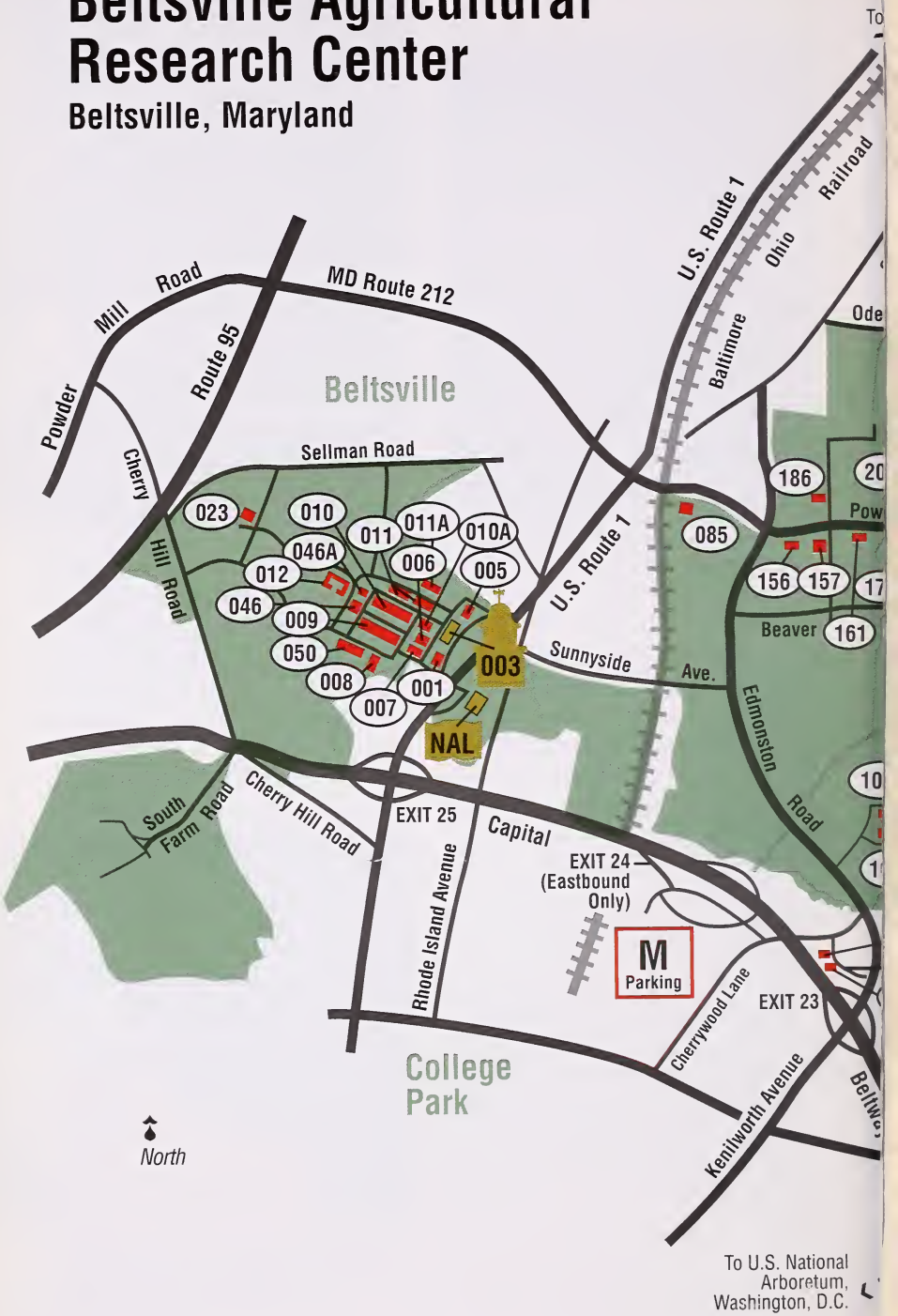
Even to a trained eye, many insect species look alike. Before entomologists can be absolutely sure of an insect's identity, they may spend weeks sifting through catalogs, scientific papers, identification keys, and museum specimens.

Nematology Laboratory

The class of wormlike creatures called nematodes is a mixed blessing for agriculture. While some nematodes are themselves serious agricultural pests, others have proven to be beneficial parasites of different pests. Scientists here deal with both good and bad. They discover behavioral and microbiological control agents that can be used as substitutes for chemical nematocides against plant parasitic nematodes. They also look at ways to develop beneficial nematodes that attack harmful insects into useful biocontrol agents.

Beltsville Agricultural Research Center

Beltsville, Maryland



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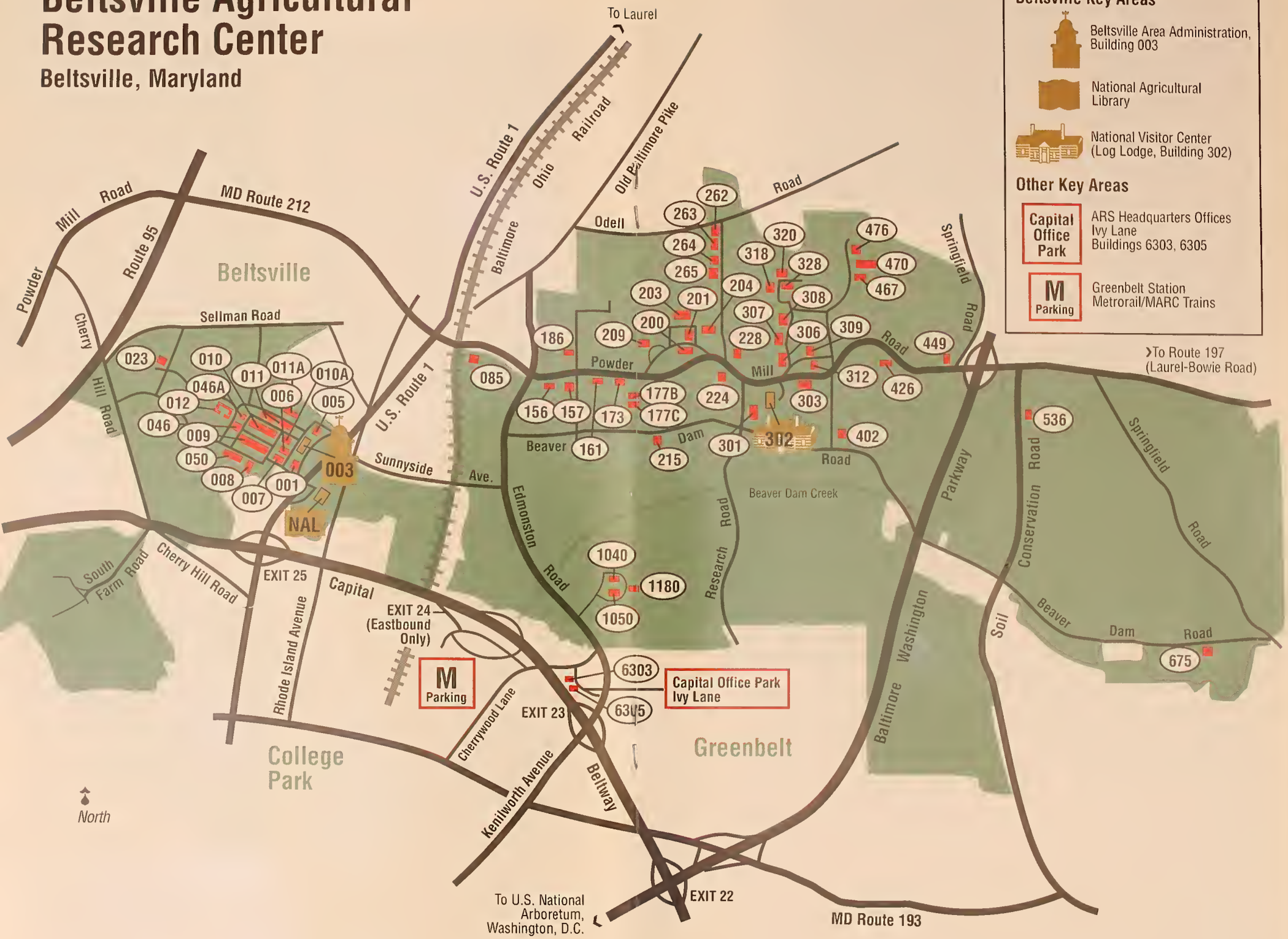


Pellets containing the fungus *Verticillium lecanii* spell doom for the soil-dwelling soybean cyst nematode.

Biocontrol of Plant Diseases Laboratory

Once a seed germinates, it's not yet out of danger—altogether too many seedlings succumb to disease. In the past, chemical fungicides have been the farmer's mainstay, but today, Beltsville scientists are developing alternative biocontrol agents, micro-organisms that can fight back against seedling pathogens. The Biocontrol of Plant Diseases Laboratory not only focuses on discovery of beneficial microbial agents, but it also looks for practical means of propagation and delivery of these friendly micro-organisms under field or greenhouse conditions.

Once they discovered new strains of beneficial soil micro-organisms, scientists put them to use in granular soil inoculants.

Looking for ways to disrupt reproduction in the corn earworm, an entomologist takes a close look at a female's mating behavior.

Insect Neurobiology and Hormone Laboratory

In the Insect Neurobiology and Hormone Laboratory, researchers are turning their knowledge of insect biology to human advantage. For example, knowing that molting is a necessary stage in insect maturation, they have gained understanding of the biochemical signals that govern the molting process and have disrupted their function. The result—insects that can never reach adulthood and reproduce.

By zeroing in on insect neurobiology and endocrinology, these researchers develop unique biochemical measures that are environmentally benign. Much of this research is targeted to disruption of insect molting, reproduction, and behavior.

Insect Chemical Ecology Laboratory

In the Insect Chemical Ecology Laboratory, scientists conduct fundamental research on chemical and biological processes associated with the behavior and development of insects. Chemical messengers and mediators studied are of plant, animal, or synthetic origin and include pheromones, attractants, deterrents, and repellants. Researchers also design ways to dispense these biologically active compounds for insect management programs. These researchers often work to support programs of other Federal agencies, such as USDA's Animal and Plant Health Inspection Service and the Department of Defense.

Insect Biocontrol Laboratory

The Insect Biocontrol Laboratory develops selective and environmentally compatible methods of controlling pest insects and weeds. The goal is to decrease the use of chemical pesticides, reduce their adverse environmental effects, and delay development of resistance in the target pests. Research is concentrated on development of novel microbial control agents with special emphasis on insect baculoviruses, microspoeitia, and new strains of Bacillus thuringiensis.

Bee Research Laboratory

Thanks to the humble honey bee, many producers are blessed with reliable crop pollination, year after year. Yet bees are not to be taken for granted; they are subject to parasitic mites and diseases. The Bee Research Laboratory works on improved husbandry of honey bees and development of environmentally sound ways to protect our valued pollinators. Scientists are also improving diagnostic tests for identification of Africanized honey bees, in support of Federal and State action agencies.

Livestock and Poultry Sciences Institute

The Livestock and Poultry Sciences Institute conducts research to increase production efficiency and profitability, and to improve the value and quality of livestock products. This institute also develops ways to prevent, control, or eradicate parasitic infections in livestock and poultry, including those that infect humans.

Parasitologists and veterinarians can borrow accessions like this swine nematode specimen from the National Parasite Collection.

Biosystematic Parasitology Laboratory

Parasites are among the most persistent problems affecting livestock. In the Biosystematic Parasitology Laboratory, scientists develop new information on the classification, distribution, and identification of parasites of animals, especially those of medical and veterinary importance. The techniques they use range from classical identification means to the latest in molecular genetic techniques. The National Parasite Collection—one of the world's largest collections of animal parasites—is maintained by this laboratory.

Discovered a new animal parasite,* Neospora caninum, *that causes widespread illness and abortion in livestock and pets.

Protozoan Diseases Laboratory

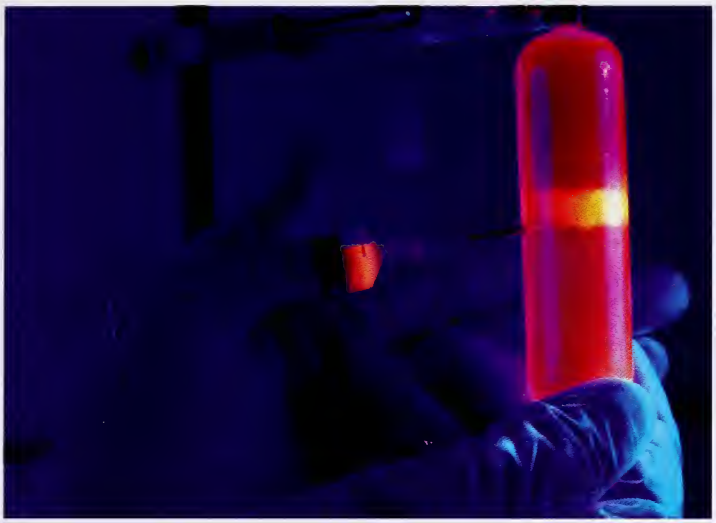
Tiny parasites called protozoa exact a fearsome price from poultry producers. Here, researchers develop methods to prevent or reduce losses from protozoan parasites of livestock and poultry, primarily chickens and turkeys. They conduct basic and applied research on the biology of the parasites, including their life cycle, development, and nutrient requirements; the interrelationships between parasite and host; and chemical and immunological methods to control parasites, including vaccines.

This little genetically defined pig will help scientists assess disease resistances or vaccine responses.

A young chick has been inoculated with a vaccine made from attenuated coccidial parasites.

Helminthic Diseases Laboratory

Parasitic infections in livestock tissues are a risk to human health and cause losses to livestock producers. Research in this lab includes both basic and applied studies in parasite biology and host-parasite relationships, with special emphasis on the immunology and genetics of the host and the application of molecular biological techniques. The information gained from this research guides development of integrated parasite control strategies, including the use of vaccines and diagnostic probes, selection of genetically resistant livestock, and the development of inhibitors.



Closeup of toxoplasma DNA being separated under ultraviolet light.

Zoonotic Diseases Laboratory

Scientists in this laboratory develop methods to prevent, reduce, and treat parasites that infect humans, livestock, and companion animals. They conduct basic and applied research on the biology of the parasites and on the ways that host species respond to them. They develop new diagnostic tests to identify new species of parasites and conduct surveys to determine how prevalent the parasites are and how they are transmitted. And they determine the best chemical, immunologic, and management methods for parasite control.

Livestock Insects Laboratory

Scientists are looking for integrated pest management strategies that will control arthropod pests of livestock, poultry, and humans. To develop these strategies, they're perfecting solar-powered electrocutor grid traps for flies, developing feed additive technology, discovering how to modify bedding materials for cattle, immunizing host cattle and chickens against blood-sucking pests, and modifying the activity of insect hormones. One of the high-priority projects in this lab is to discover ways to control populations of Lyme disease vectors such as the deer tick.

Gene Evaluation and Mapping Laboratory

A physiologist examines an animal embryo under the microscope.

In their quest to improve animal productivity, scientists are working to genetically engineer livestock. This laboratory develops knowledge of the structure and function of genomes of livestock and poultry. Scientists here work to improve productive performance through better selection efficiency and insertion of new genetic material. Research methods include molecular biology, genetic manipulation of embryos, and cell culture to determine expression of genes in physiological systems that regulate productivity.

Produced the first transgenic farm animals.

Nonruminant Animal Nutrition Laboratory

Nonruminants—the term applies to poultry and swine—are increasingly popular sources of meat in the American diet. Scientists studying nonruminant animals are determined to improve the desirability of meat. Here, fundamental research takes place on genetic and environmental factors affecting differentiation, growth, and composition of body weight accretion (emphasizing lean tissue and less fat deposition). Researchers also develop ways to accurately predict live animal composition. Through a better understanding of the physiological stresses created by gestation, egg production, and lactation, they recommend ways to increase the number of offspring reared per breeding female.

Scientists weigh a calf that has been treated with growth-regulating hormones.

Ruminant Nutrition Laboratory

What should producers feed to their cattle and sheep? In what quantities? How do these animals' bodies assimilate nutrients? How efficiently do they convert feedstuffs to foods for human consumption? Research in the Ruminant Nutrition Laboratory aims to improve the economic potential of feedstuff conversion into safe and healthful food for human consumption through meat and milk production. Fundamental research emphasizes the physiological and biochemical bases of intake, microbial degradation and digestion of feedstuffs, absorption and transport of nutrients, and biochemical synthesis of meat and milk.

Germplasm and Gamete Physiology Laboratory

These scientists work to improve the genetic, reproductive, and productive efficiency of livestock and poultry. They find ways to preserve sperm and embryos. They study embryonic development, and molecular and cellular endocrinology of reproductive processes. Yet another area of concern is gender preselection—sorting gametes by sex. They also perform a service to research as a whole: The USDA Animal Hormone Program provides laboratories worldwide with reference preparations of animal pituitary hormones, antisera, and related reagents for endocrine studies.

Animal Improvement Programs Laboratory

Scientists advance statistical and computer methods for genetic improvement of economically important traits in dairy animals and implement procedures to produce nationwide genetic evaluations. They research improved technical procedures for obtaining and summarizing data in support of the National Cooperative Dairy Herd Improvement Program.

Milk Secretion and Mastitis Laboratory

Researchers in the Milk Secretion and Mastitis Laboratory study lactation and endocrine physiology in dairy cows to increase and sustain high milk yield. They also work to stop mastitis by strengthening the cow's own physiological defense mechanisms, such as white blood cells, to reduce the rate of infection and the severity of disease.

Product Quality and Development Institute

Scientists and engineers in the Institute search for ways to improve the quality and ensure the safeness of fresh fruits, vegetables, red meat, and poultry products.

Discovered that postharvest application of calcium to apples reduces virulence of storage diseases and could substitute for pesticides, leading to improved marketability.

Unraveling the mysteries of ripening may allow scientists to slow down the aging process in fruits and vegetables.

Horticultural Crops Quality Laboratory

Scientists in the Horticultural Crops Quality Laboratory work to identify, measure, and protect desirable qualities in fruits and vegetables from the time of harvest until they reach the consumer. The laboratory's work emphasizes cellular biology and hormonal control of ripening and aging. To help reduce deterioration, scientists develop improved methods to control postharvest diseases and better ways to store and handle perishable produce.

Pesticide Research Staff

Better pest control technology is essential for American agriculture. The staff assembles and provides information on the benefits, risks, and economic value of pest control technology. Specialists here at Beltsville also coordinate the minor use pesticide program and provide data on experimental materials being evaluated as pest control agents.

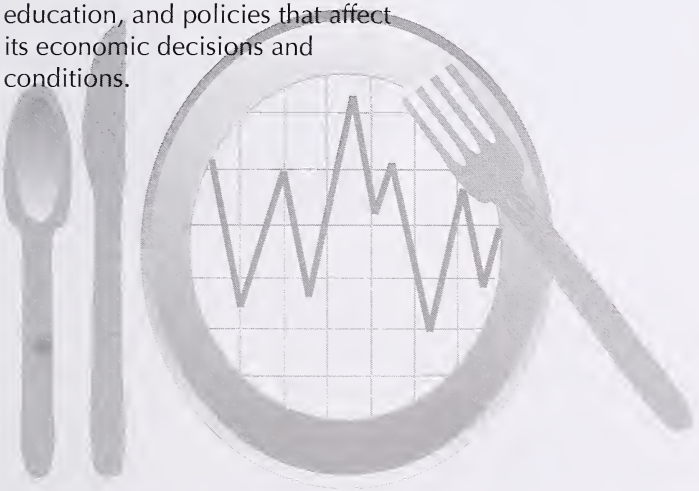
Meat Science Research Laboratory

Research focuses on the composition, quality, and safeness of meats, with emphasis on development of high-lean, low-fat meat and meat products that are palatable and nutritious. Biochemical studies reveal mechanisms that control fat content and composition of meat. Meat scientists develop data on specifications and standards for quality of meat and meat products. Chemists develop methods for detecting and identifying residues of antibiotics in meat.

Researchers in Beltsville grade carcasses for quality and yield.

Family Economics Research Group

The family is the cornerstone of American life and a unit whose interests and composition are continually changing. This group determines the economic well-being of families and studies how American families acquire, allocate, and manage financial resources under varying economic and social conditions. These social scientists measure and compare economic well-being across groups of families, determine financial allocation patterns, and describe interactions of family financial behavior with the general economy. The research goals are to help the American family by expanding the research base for guidance, education, and policies that affect its economic decisions and conditions.



Instrumentation and Sensing Laboratory

Researchers develop new instruments, sensors, and techniques to measure chemical and physical properties of agricultural products. Emphasis is on nondestructive methods for measuring product quality, composition, and safeness. Quick detection and elimination of damaged or diseased poultry carcasses, apples that have impaired storage properties, and wheat that has inferior quality are among research objectives.

Beltsville Human Nutrition Research Center

This Center conducts research relevant to human requirements for energy, protein, carbohydrates, lipids, vitamins, minerals, and new "nutrients." It also looks at their bioavailability from commonly eaten foods to ensure optimal function throughout the life cycle. The Center also develops dietary strategies, such as ways to postpone the onset of nutrition-related debilitating diseases.

Demonstrated technology that uses near-infrared light combined with computerized data analysis to instantly measure percent of body fat, water, and protein without harming the subject.

Food Composition Laboratory

In the Food Composition Laboratory, researchers design and develop new and/or improved measurement systems for analysis of nutrients and other important constituents in foods. They develop sound food-supply sampling techniques, transfer new technologies to industrial, academic, and government laboratories worldwide, and analyze the nutrient content of foods with tested techniques and supply these analyses to interested groups.

A nutrition scientist refines procedures for measuring vitamin A and other micronutrients in tomato-based products.

Diet and Human Performance Laboratory

Metabolism and Nutrient Interactions Laboratory

Nutrient Requirements and Functions Laboratory

These three laboratories are teamed to several specialized missions, described below.

What does proper nutrition really mean, in terms of our daily diet? Scientists in these labs focus on determining human requirements and basic mechanisms of action for specific vitamins and minerals. They identify chemical forms and bioavailabilities of vitamins and minerals in foods. They work to develop analytical instrumentation and techniques for assessment of minerals and vitamins in human nutrition.

Of all the major sources of energy we take in, there's only one that it's recommended we eat more of—carbohydrates. Several newly available carbohydrates are being introduced into the U.S. diet as fibers, alternative sweeteners, or fat substitutes. Long-term human health consequences of these changes in composition have not been adequately determined.

Tasty loaves of bread contain high-amylose cornstarch in place of wheat flour.

Researchers uncover the nature of metabolic interactions that occur between carbohydrates and other food components. They are examining the effects of carbohydrates on population groups with different genetic responses to identify individuals at particular risk. The overriding objective is to establish requirements for carbohydrate intake by humans and determine how to best meet these requirements to improve the health and quality of life in the adult population, including that of senior citizens.

Dietary fat—what's its effect on health and quality of life? These nutrition scientists determine what effects dietary fat has on metabolic and other physiological factors. From such studies, the scientists can devise recommendations on optimal intake of fat and its constituent fatty acids. The research uses human volunteers and experimental animal models to investigate needs for essential fatty acids under different physiological conditions. It also investigates the bioavailability of vitamins involved in lipid metabolism and effects of the dietary lipids and cholesterol on physiological variables related to good health.

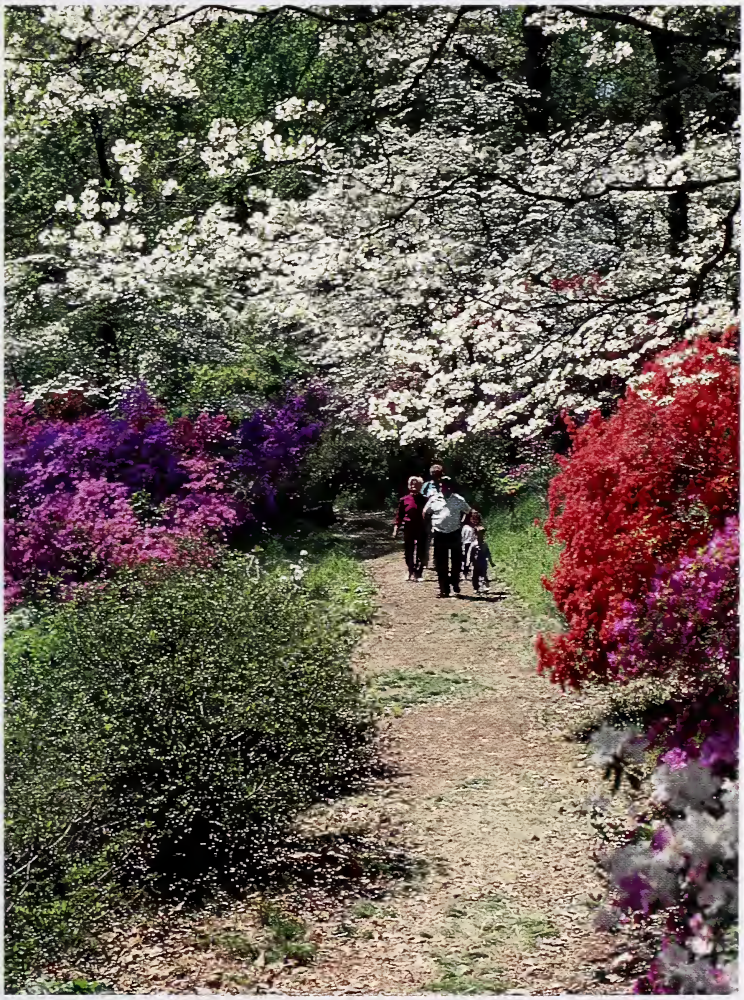
Work performed at the Beltsville Agricultural Research Center has a direct bearing on what's available in the American grocery store.

A research associate prepares SOS Chromatest plates. The test can be used to assess how diet influences a person's risk of developing certain forms of cancer.

These labs are also determining human energy and protein requirements as influenced by diet, activity, and environment. Scientists identify, quantify, and characterize the physiological processes involved in total energy expenditure as they relate to control of the composition of the body. They also investigate the source and amounts of nutrients consumed as they relate to maintaining desired body weight. Other objectives are to improve methods to predict energy values of foods from chemical or physical measurements, to characterize metabolic responses to proteins, and to develop methods to indirectly assess body composition and energy expenditure of human subjects.

U.S. National Arboretum

Parklike in its beauty, the U.S. National Arboretum in Washington, D.C., is the site of significant research on trees, shrubs, and herbaceous plants. It also serves to educate the public regarding these plants.



The Arboretum's azalea trail is world famous as a showplace for Glenn Dale azalea hybrids.

New culture techniques have enabled researchers to bring forth lilies in a new palette of color.

Floral and Nursery Plants Research Unit

Some of today's hottest agricultural products are flowers, potted plants, and landscape trees and shrubs, due in part to work performed in Beltsville and at the National Arboretum. Here, lines of florist and nursery crops are improved, as are methods of detecting viruses and diagnosing disease. New methods in cell culture and genetic engineering enable scientists to improve whole plants. Biological pest-control practices developed from the study of insect behavior and ecology help to reduce floral and nursery crop producers' dependence on chemical pesticides.

The Arboretum program places major emphasis on woody plant research. Current work emphasizes taxonomic and cytological studies on identification and classification of cultivated woody plants, breeding of improved varieties, and evaluation of existing, newly derived, or newly introduced cultivars. Scientists solve problems of plant propagation and assist other agencies and institutions by disseminating needed plant stocks, materials, and information. At its Ohio research site, germplasm is evaluated for its adaptation to the climate of that area.

Issued the USDA Plant Hardiness Zone Map for Canada, the United States, and Mexico to guide gardeners and landscapers in selecting outstanding ornamental plants.

Scientists at the National Arboretum review specimens of woody plants collected during an expedition to China.

Accurate identification is essential to all plant research. The National Arboretum herbarium, a worldwide collection of 600,000 dried, pressed specimens, is essential for the botanical study and identification of cultivated plants and related plant breeding projects at the Arboretum and for support of cooperative programs within the USDA. The herbarium staff answers technical inquiries and lends its collections to visiting scientists and others in the United States and abroad.

Germplasm Unit

The role of the U.S. National Arboretum's Germplasm Unit is to collect, introduce, maintain, distribute, evaluate, and preserve germplasm of woody landscape plants. This involves development of germplasm collections of trees and shrubs used in street, highway, and landscape plantings. These collections are intended to contain the necessary genetic diversity for development of landscape plants adapted to stressful urban and highway environments, as well as to require less maintenance and the reduced use of pesticides.

Education Unit

Guided tours highlight the Arboretum's gardens, plant collections, natural areas, and herbarium. They're led by Arboretum staff members, specialists from various plant societies, and members of the Volunteer Guide Service of the National Capital Area Federation of Garden Clubs, Inc. These guided tours are popular; reservations for group tours should be made well in advance of the proposed visiting date. Lectures, classes, garden walks, and other education programs are also regularly conducted by staff and outside specialists.

Gardens Unit

At the center of the National Arboretum's educational and research programs are its labeled and carefully documented plant collections. These collections are arranged in generic or botanical groupings, gardenlike or naturalistic plantings, and demonstration plantings.

The gardens include thousands of azaleas interplanted with snow-white dogwoods. There are major collections of crabapple, holly, magnolia, viburnum, crapemyrtle, flowering cherry, ferns, and wildflowers. There are collections of dogwood, dwarf conifers, and a 2-acre National Herb Garden that offers a magnificent view of the National Capitol Columns. The National Bonsai Collection housed at the Arboretum is recognized as one of the finest collections in the world. The New American and Friendship Gardens contain a broad array of perennials, bulbs, and ornamental grasses.

The Herb Garden.

Other ARS and Related Activities at the Beltsville Agricultural Research Center

Many of the Agricultural Research Service national management and support staffs have offices at the BARC. Also located at BARC:

The National Agricultural Library

The National Agricultural Library (NAL), housed in a prominent 15-story building, contains a vast collection of printed materials on agriculture and related sciences (over 2 million volumes). Computers and other modern techniques provide instant information to researchers, technicians, and the general public. NAL is international in scope, embraces many languages, and covers all the sciences supporting agricultural research.

Other USDA agencies with offices at BARC:

- Agricultural Marketing Service
- Animal and Plant Health Inspection Service
- Food Safety and Inspection Service
- Soil Conservation Service
- Federal Grain Inspection Service

Other Federal agencies with offices at BARC:

- Environmental Protection Agency
- Food and Drug Administration

ARS National Visitor Center

The National Visitor Center, informally known as the Log Lodge, provides guided tours and helps orient visitors. Exhibits, audiovisuals, guided tours, and further information on food and farm services are featured. The Log Lodge was built almost entirely of local materials in 1936-37 by the Civilian Conservation Corps.

Guests are welcome to take guided BARC tours. The tours are given by appointment and vary in content according to the scientific and agricultural interests of visitors. For details, call or write:

ARS National Visitor Center
Building 302, BARC-East
Beltsville, MD 20705
301-504-8483 or 301-504-9403